Chemical & Engineering NEWS
November 2, 1981

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# Synthetic fibers' recovery flattens out

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CONGRESSIONAL INFO SERV
4520 EAST WEST HWY SUITE 800
BETHESDA MD 20014

November 2, 1981
Volume 59, Number 44
CENEAR 59 (44) 1–60
ISSN 0009-2347

# Chemical & Engineering NEWS

*Cover:* Operator at American Hoechst plant at Spartanburg, S.C., monitors spooling of polyester filament

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# Synthetic fibers recovery pauses

**Shipments are slowing in stalled U.S. economy, but most producers believe that fibers will pick up quickly when economy improves**

Despite some displeasing, hopefully temporary, current news, the U.S. synthetic fibers industry finally may be coming into its own from a more long-term view. The payoff could come fairly quickly once the U.S. economy picks up again.

Victims in the past of massive overcapacity and wildly fluctuating inventories, fiber producers are working hard to get both of these problems under control. And thus far, even under slowdown conditions, they are succeeding.

Plant capacity has been cut in all three of the large-volume noncellulosics—polyester, nylon, and acrylic. And inventories, though swollen relative to shipments, have not risen much in absolute figures.

"It's not a tremendous year, but it's a profitable year," sums up one industry expert. And it seems to be true.

In possibly the worst case, Monsanto had a $300,000 pretax loss in its textile division in the third quarter; for the nine months it had a pretax profit of $24.2 million. Even the small loss in the third quarter at Monsanto looks good against the $43.4 million it lost (pretax) in the same period of 1980. In the first nine months of 1980, the company's textile division racked up a loss of almost $115 million pretax.

At Akzona, chairman Claude Ramsey attributes much of the company's change from a 32-cent share after-tax loss in last year's third quarter to a 40 cents-per-share profit this year to Akzona's American Enka division, the company's fiber arm.

At Celanese, earnings for U.S. fiber operations in the third quarter increased 26% to 95 cents a share after tax from 70 cents a share in the same period last year. Most of this gain is in polyester, profits for which increased 164% to 29 cents a share. For the nine months, U.S. fibers earnings at Celanese increased 81%.

At press time, Du Pont, the largest fiber producer, had not reported its third-quarter results.

Producers have decided that it is better for them to cut capacity than to cut prices in the face of excess product. Over the past two years, official capacity of noncellulosics has been chopped about 2%. In some fibers, the capacity reduction has been as much as 5%. This at a time when capacity in most other parts of the chemical industry still is rising.

The capacity reduction has helped keep inventories in line, but producers have gone even further. They are no longer chary of temporarily closing plants or production lines when inventories of individual fiber types get out of line. The standard rule of thumb is that inventories should be equal to or less than one month's shipments. In general, producers have followed this rule in 1981. Only in July did inventories of noncellulosics get above the one-month shipments level, and even then it was by less than one day.

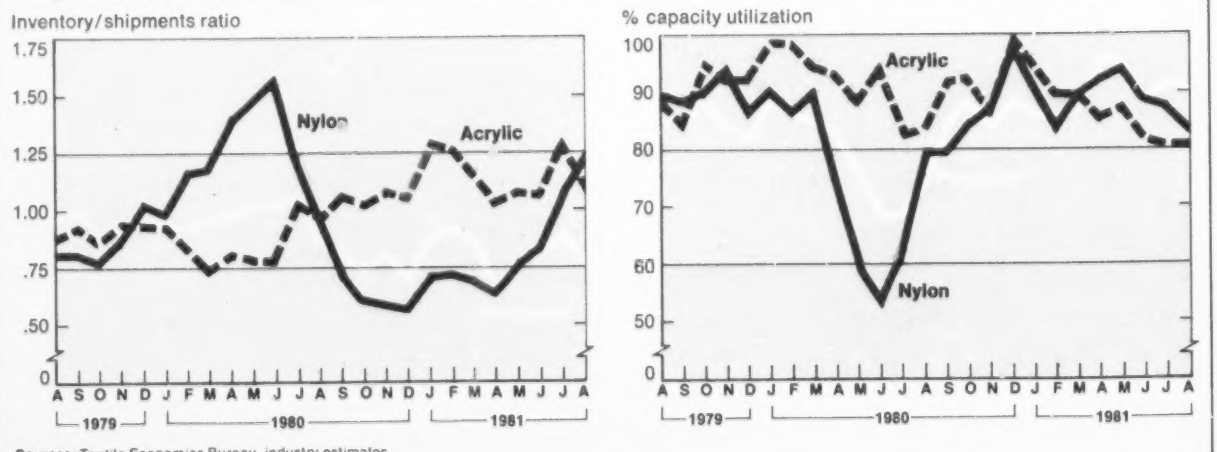
Further, producers say, inventories at downstream textile mills also are quite low. In fact, they see customers forcing inventories back on them because of high interest rates, which boost storage costs. With the low inventories at mills and fairly tight inventories at the producers' end, noncellulosic fibers makers see their product going short quickly if there is a turnaround in the economy.

In other words, the fibers business is hovering not far shy of prosperity for the first time in seven years. Although fiber firms still have one of the most quirky markets of any chemical product, their fundamentals, especially their high capacity use, look promising.

For details on the immediate outlook for polyester, nylon, and acrylic, see the following pages.

*William Storck, New York*

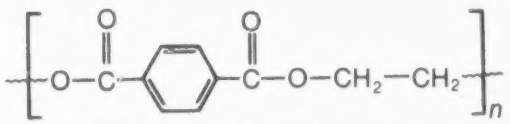
**Polyester generally has outperformed nylon and acrylic in inventory control, capacity use**




**Sources:** Textile Economics Bureau, industry estimates

## Key Polymers

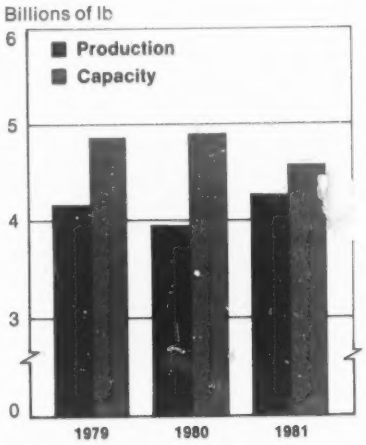
# Polyester



Poly(ethylene terephthalate)

- ***Demand up slightly***
- ***Capacity down***
- ***Some discounting***

### PRODUCTION/CAPACITY




### HOW MADE

*Reaction of ethylene glycol with dimethyl terephthalate or terephthalic acid to produce resin that is spun into fiber*

### MAJOR END USES

*Apparel 62%, home furnishings 17%, tire cord 10%*

### FOREIGN TRADE

*Exports—rising to more than 800 million lb in 1981, imports—will rise to about 20 million lb*

### PRICES

*150-denier textured filament, $1.17 per lb; 150-denier feeder filament, 92 cents to $1.00 per lb; staple, 84 cents per lb*

### COMMERCIAL VALUE

*About $3.85 billion for total production, 1981*

In general, polyester fiber this year is in the best shape of all of the large-volume U.S. noncellulosic fibers. And not just by default.

Demand for polyester is up across the board from depressed 1980 levels. And producers are optimistic that they will be able to hold prices, if not at official listings, at least at profitable levels.

Polyester shipments for the first eight months were up 8.2% over the like period of 1980. This 1980 period had been down 5.6% from the year before. Thus, polyester shipments for the first eight months of 1981 are running 2.1% ahead of 1979, their last good year.

Specifically, it is polyester staple (the chopped form) that is holding the fiber above the 1979 levels. By contrast, industrial polyester shipments are off 17% from where they were in 1979, those of low-denier industrial are down 12%, and textile polyester shipments are down 1.5%. Thus total polyester filament shipments, while up 10.3% from the first eight months of 1980, are still off 5% from the same period in 1979.

Staple is a different story, however. Shipments of staple were virtually flat in the first eight months of 1980. Thus their 7% rise over that period this year translates into a like increase over the first eight months of 1979.

Producers say that polyester staple has been helped considerably this year by exports, especially to China. Exports, through the first half of 1981, were running about 20% ahead of the first half of last year.

Shipments of polyester fibers generally have been trailing downward for the past five months. They reached a year-to-date peak in April at 339 million lb and then demand began to decline, dropping 8% by July to 344.3 million lb. Demand picked up again in August to 369.4 million lb, but producers say that this was largely on the strength of the inceased exports.

Polyester fiber producers have been very careful about inventories, keeping them well below the industry level of one month's shipments. The result is that pricing in polyester, like that in other fibers, has held up fairly well this year. There is some discounting in textile filament and in staple, which is still listed at its first-of-the-year price of 84 cents per lb. Other types of polyester are fairly firm, however, having received a price increase in May. Polyester textile filament's price, in spite of being discounted 2 to 3 cents per lb, is still higher than its level of $1.07 per lb at the first of the year. The current list price is $1.17 per lb.

Producers say that they have finally learned their lesson and will shut down plant capacity rather than let overcapacity bring prices down to unprofitable levels. Thus, official capacity is about 6% below what it was a year ago.

For the next 12 months the wretched construction market will continue to have a dampening effect on polyester fortunes. However, producers are hoping for an upturn in demand for polyester apparel.

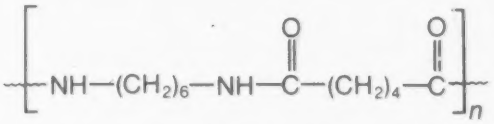
In apparel, producers speculate that there is a psychological factor at work: When consumers cannot afford big-ticket durable goods, they tend to buy more clothing. However, this theory has never really been tested. Moreover, another factor—a possible switch in the industry on the composition trend in polyester-cotton blends as cotton prices fall—perhaps could dampen a polyester upturn linked to apparel. The price of cotton has sunk like a stone in recent months. If cotton prices get low enough, some producers believe that there may be a change to more cotton in blends, reducing the amount of polyester staple used. Others believe that textile mills would find the change too expensive.

One thing that producers agree on is pricing. They think that unless the situation improves, polyester will not see its normal first-of-the-year price increase in 1982. That could be a problem. If flat 1980 prices of raw material ethylene glycol and dimethyl terephthalate start moving up again before polyester makers can pass them along in fiber price hikes, the result would be tough financially. Profit margins, which are in some cases rather thin, could turn down very quickly.

In general, though, polyester producers think they can hold out financially through the first half of 1982 in the current general economic slowdown. Then they are hoping that the last half of the year will bring some upturn in U.S. demand so they won't have to depend so heavily on the uncertainties of exports.

## Key Polymers

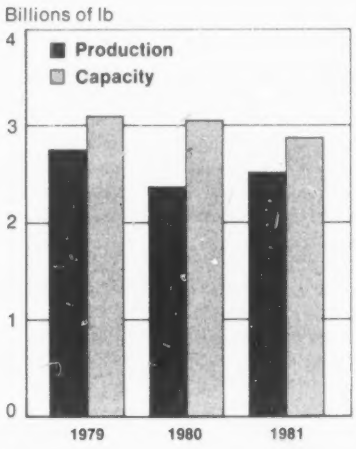
# Nylon




Nylon 66

- ***Demand down***
- ***Capacity off***
- ***Prices discounted***

### PRODUCTION/CAPACITY




### HOW MADE

*Nylon 66—reaction of adipic acid and hexamethylene diamine to form hexamethylene diammonium adipate, which is then polymerized; nylon 6—polymerization of caprolactam by water; both types are then spun*

### MAJOR END USES

*Home furnishings 59%, apparel 20%, tire cord 11%*

### FOREIGN TRADE

*Exports—rising to more than 210 million lb in 1981, imports—will increase to about 30 million lb*

### PRICES

*2500-denier bulk continuous filament, $1.45 per lb; carpet staple, $1.20*

### COMMERCIAL VALUE

*About $3 billion for total production, 1981*

No two ways about it—nylon is in trouble, in a year that promised better when it began. Now the worst off of any major U.S. fiber, nylon has once again fallen victim to its peculiar market lineup. For, although the fiber is popular for its apparel uses, most of it goes into housing-related outlets, especially carpets. Since this is where 60% of nylon winds up, the comatose construction industry has driven down the nylon business about as badly at the moment as in last year's recession.

Last year, nylon production fell about 13% from 1979 and shipments were off even more at 17%. Nylon staple suffered worst with a 31% decrease in production. Most of nylon staple goes into carpets. Nylon carpet filament in 1980 was off from 1979 levels.

On the surface, 1981 looks better. Total nylon shipments from January through August moved up slightly for an 8.5% increase over the first eight months of 1980. However, this is still more than 10% below the same period in more prosperous 1979.

More serious, demand for carpet nylon has been trailing off since April. Shipments of carpet filament hit 73.4 million lb that month but then declined 29% to 52.1 million lb in August. The same situation has occurred in nylon staple. August shipments of 52.8 million lb were 34% below April's.

September continued the decline. Carpet filament in September was off about 8% from August; staple was down another 5%. This augurs poorly for nylon, since September is normally pickup time from seasonally lower production in July and August.

So the end of nylon's troubles may not be in sight yet. The construction industry still is in the doldrums. Until it turns around, carpet nylon will suffer, having to rely largely on the replacement market for carpet and other uses.

The demand trough is reflected in pricing. The list price for workhorse 2500-denier bulk continuous filament used for carpets is $1.45 per lb, compared to about $1.25 per lb at this time last year. However, producers say discounts are so large in this filament that it is hard to know just what the current price is.

In response to poor demand for carpet nylon, producers have cut back on plant capacity. Production capacity of 907 million lb annually in May of this year was officially about 5% below its November 1979 level. But producers say that there have been further unofficial, temporary curtailments that have helped keep inventories and prices in better shape than they would be otherwise. Before these curtailments, according to industry experts, the situation got so bad that the discounted price of bulk continuous filament was below that of feedstock caprolactam.

Like polyester, nylon is getting a little relief in profit margins from flat feedstock costs. The price of caprolactam is generally about the level it was the first of the year, whereas the price of nylon is up somewhat.

Because of shutdowns in nylon capacity, capacity utilization is well ahead of 1980, although it is currently slipping. In 1980, capacity utilization averaged about 78% of the nameplate maximum for the year. This year, the average likely will move up about nine percentage points to about 87% of the total.

However, like the other noncellulosics, nylon's capacity utilization rate seems to have hit a peak in the spring. Capacity utilization was about 93% in the peak shipments month of April and 95% in the peak production month of May. It has since slipped to about 84% in August and probably will be somewhat lower in September after a slight nylon production drop that month.

Among specific nylon grades, staple is probably the worst case. Capacity use for staple in September probably will be 75% or below. Producers believe that further capacity cutbacks may be called for to shore up the staple price, now a discounted $1.20 per lb.

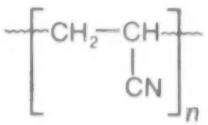
For the near future, producers look for some further market erosion over the next few months. They are hoping for a pickup in the second quarter of 1982 as the general economy gets back on track.

Thus, though many producers expect a pickup next year, they believe that it could take until late in the year before production and shipments get back to 1979 levels.

So chalk up about a one-year gap in the nylon recovery that looked so hopeful at the beginning of 1981. The construction market holds the key.

## Key Polymers

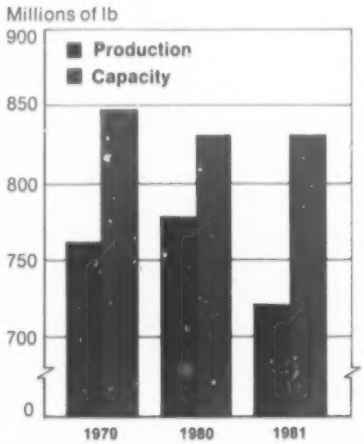
# Acrylic



Polyacrylonitrile

- ***Demand off***
- ***Capacity stable***
- ***Prices firm***

### PRODUCTION/CAPACITY




### HOW MADE

*Polymerization of acrylonitrile, which is made by a catalytic reaction of propylene and ammonia*

### MAJOR END USES

*Apparel 70%, home furnishings 30%*

### FOREIGN TRADE

*Exports—rising to about 200 million lb in 1981, imports—falling to about 13 million lb*

### PRICES

*3-denier staple for apparel, 98 cents to $1.10 per lb*

### COMMERCIAL VALUE

*More than $720 million for total production, 1981*

Acrylic fiber faces a painful profits pinch unless conditions improve quickly, which is unlikely. Alone among major fibers holding up through the 1980 recession, acrylic has joined the pack in 1981 with a general drop in business.

Acrylic's odd market behavior these two years is tied to the fact that consumer tastes in sweaters and apparel dominate acrylic's use pattern. Last year these clothing items were "in"; this year, apparently not so much.

Through the first eight months of this year, U.S. shipments of acrylic fiber dropped 7.8% to 484.3 million lb from the same period in 1980. The eight-month shipment figures for this year also are about 6% behind the first eight months of 1979. So like nylon, acrylic has a long way to go on its road to recovery.

Such recovery for acrylic may not be easy, tied as it is to apparel. One producer says that it's difficult, if not impossible, to predict exactly what is going to happen. "You just don't know how the fashions are going to change," he says. "What we need is a cold winter," he adds, referring to the large acrylic market in sweaters and outerwear, which use its wool-like properties.

Fortunately, exports of acrylic fiber are more than making up the ground lost last year. In 1980, exports fell about 16% to 75 million lb from 1979. This year, however, things are looking better. Exports through the first six months have risen 16% to more than 100 million lb from first-half 1980. Producers expect to finish the year with exports showing a good increase from last year—perhaps to just above 200 million lb. Although this still will be below 1979, it will go a long way to help prop up production in the face of falling U.S. demand.

Imports, a far smaller influence, are going the way of U.S. demand. Flat in 1979 and 1980, imports will drop this year. For the first six months, they were down 12% to about 9 million lb. Producers expect imports to continue falling for the rest of the year, finishing about 25% under the 18 million lb racked up in 1980.

U.S. nameplate production capacity for acrylic fiber is expected to remain at about 830 million lb. This is down from 848 million lb in 1979. Producers say that there should be no additions for some time; if anything, there may be a further cut. If this cut does not come in U.S. capacity—and it likely will not—it may come in Canada, which is a big exporter of acrylic fiber to the U.S.

With the cut in acrylic capacity in 1980, capacity utilization moved up about 4 percentage points that year in spite of an output increase of just 2.4%. This year, however, capacity use is declining. After starting out in January at about 96%, it quickly fell into the 80's. By August, capacity utilization was down to 81% with little prospect for its improvement in September. It now looks as if acrylic fiber will finish the year with plants running at an average of about 86% for all of 1981. In 1980, capacity utilization averaged about 94%.

The falling plant operating rate has not had much effect on list prices, producers say, although it may delay further price increases.

Prices for 3-denier staple for apparel run from 98 cents per lb to about $1.10 per lb. This is a much broader range than normal, indicating that there may be some price weakness. Last year at this time, there was just a 2-cent variation from 88 cents to 90 cents per lb.

The pattern of price increases this year also indicates some weakness in the market. Instead of increasing prices of all acrylic fibers at the same time, producers have been selective, raising prices of different types of fibers at different times.

In spite of this, however, producers say that pricing is fairly firm. It had better be, if they hope to maintain their profit margins. Acrylic fibers are the one noncellulosic where feedstock costs are rising. Precursor acrylonitrile prices are edging up, and upstream propylene pricing is "strong." Propylene is in somewhat short supply because of shutdowns in coproduct ethylene.

For the coming year, producers hope for a reversal of the current downturn, with shipments getting back up to 1980 levels by the third or fourth quarter.

Producers are, however, worried about profit margins for next year as feedstock costs continue to climb. If companies can start increasing prices in some orderly manner, things likely will work out. If prices can't move, acrylic fiber may resume its reputation as the weak sister of the noncellulosics.

# Ph.D. women's careers in academia lag men's

Though women with doctorates are more likely than their male colleagues to work at universities, the university is not a very equitable place for them.

If women earned their Ph.D.'s more than 20 years ago, their chances of now being full professors are only 73% of those of men with the same experience. If they earned their degree five to 10 years ago, their chances of having tenure are only 67% of those for comparable men. And their salaries, on average, will be 5 to 18% lower than those of men with the same degree and experience.

These are some of the findings of the National Research Council's latest examination of the differences between the careers of men and women in academia. Their report, "Career Outcomes in a Matched Sample of Men and Women Ph.D.'s," was prepared by the council's Committee on the Education and Employment of Women in Science and Engineering.

Studies that find women scientists are paid less and spend a larger part of their careers in lower level academic positions than their male colleagues have been made before. The American Chemical Society, for example, has much data that shows these trends for women chemists. In fact, the National Research Council itself conducted a study in 1979 that reached similar conclusions about women scientists in academia.

**Preferential promotion of men greatest in chemistry**

| | Ratio of men to women[a] 1960–69 | 1940–59 |
|---|---|---|
| Chemistry | 2.4 | 1.6 |
| Biological sciences | 2.1 | 1.7 |
| Psychology | 1.9 | 1.5 |
| Physics | 1.6 | 1.0 |
| Mathematics | 1.4 | 1.1 |
| Social sciences | 1.3 | 1.3 |
| Other humanities | 1.3 | 1.4 |
| Languages and literature | 1.2 | 1.4 |
| All fields | 1.5 | 1.4 |

a Ratio of male full professors to female full professors in 1979 by year of Ph.D. degree.

What is new about the present study, explains Lilli S. Hornig, who chaired the committee that prepared both the present study and the earlier one for NRC, is that it considers factors other than discrimination that might cause differences in the careers of men and women. Even taking these other factors into account, however, Hornig says the study "corroborates our earlier findings in virtually every detail." Among these factors are women's presumed larger investment of time and energy in marriage and parenting and their presumed restricted geographic mobility.

The present study tries to minimize the influence of these factors by matching one woman with two men to form a group of three people who all have the same characteristics. It then looks for patterns of promotion and salary among the people in these matched groups. There were 5164 of these groups in the study covering people who worked in various areas of science as well as languages and the humanities in 1979.

But even this careful matching does not make the career patterns of women and men at universities the same. "With male and female scientists and humanists closely matched by education, experience, type of employment, and even subfield in many cases, none of the differences we have noted previously in career progress disappear and few diminish," Hornig says. "Women remain less likely to be employed although seeking employment, their careers are apt not to develop as fully and they remain significantly less well paid."

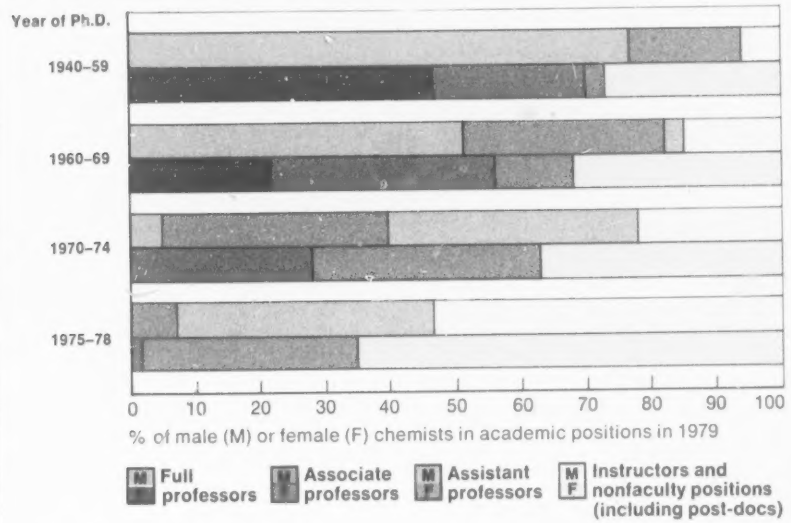
Specifically, the study finds that of academically employed Ph.D.'s who were surveyed 20 or more years after obtaining their doctorates, 87% of the men but only 64% of the women were full professors. For chemistry Ph.D.'s the difference is even greater: 77% of the men but only 47% of the women were full professors.

Salaries, too, trail for women, and the salary difference between men and women is greatest in chemistry. For full professors of chemistry with more than 20 years experience, women earned $5500 (or 18%) less, on average, than men did.

At the other end of the scale, for academics who have earned their doctorates in chemistry since 1975, women earn $3300 (or 15%) less, on average, than men do. For these younger academics in all disciplines, the salary difference is $900 or 5%.

The report is available, for $10, from National Academy Press, 2101 Constitution Ave., N.W., Washington, D.C. 20418. □

**Promotion at all levels comes later for women chemists**




Source: National Research Council

# Project Selection in the 1980's

***Business fluctuations, inflation, shifting exchange rates create new hazards for profitability analysis***

**James B. Weaver**
Wilmington, Delaware

The chemical industry has changed greatly since the 1960's, but the nature of the decisions facing its management has not. Management's most important decisions—and the most irreversible ones—still deal with the proper use of investment opportunities: expansions, new products, acquisitions. Such decisions remain a major responsibility of boards of directors.

Expanding assets is relatively easy, to be sure. The challenge lies in expanding profits along with assets.

As I said in C&EN 20 years ago: "A major objective of any manufacturing corporation is to provide the greatest possible long-term profit to its stockholders. This requires that its assets be used wisely and that they be increased in dollar value at the highest possible rate. . . . Nothing is more important than a series of successful capital investments in establishing a record as a profitable growth company."

For the past 20 years or so, analytical techniques have been available for evaluating the potential profitability of investment proposals, usually in terms of return on investment. This evaluation is derived from the net cash flow expected during the economic life forecast for the project. The future annual cash-flow schedule, in turn, is based on forecasts or projections of the key determinants of future income (such as sales volume, prices, capital requirements, and operating costs). Because funds are more valuable the sooner they are earned, future earnings are discounted, by compound-interest techniques, to a reduced current value for use in calculating a single, quantitative estimate of the project's overall profitability. The two most widely used techniques for doing this are very similar and usually lead to the same conclusion for any given set of future circumstances.

If there is a consensus accepting one set of cash-flow forecasts, this analysis permits management to judge whether a proposed project meets company standards for return on investment. The analysis also can be used to compare various projects available to the company at any one time or to weigh the effect of slightly different versions of a single project (variations in plant capacity or processes, for example) to choose the most profitable. And it can be used, too, to study the sensitivity of future earnings to changes in the key forecasts and thus to investigate risk.

The intent of such an analysis is not to replace management's judgment, but to simplify numerical interrelationships among revenues and costs in a complex project. Thus management has more time for considering other risks that do not lend themselves to quantification. As I also pointed out 20 years ago in C&EN, "By reducing a myriad of numbers to a few simple indicators, it permits management to focus attention on the many intangibles involved."

In the two decades since such methods for project analysis won wide acceptance, only minor improvements have been made. However, the advent of computers, with their massive ability to rapidly manipulate complex sets of numbers, has reduced the time needed to study many possible situations. When analysts were tied to mechanical calculators and slide rules, they often were a bottleneck limiting the number of variations that could be studied before a deadline. Now, many inputs can be stored in a computer, so the effect of a change in any forecast can be churned out in a few minutes or hours.

This suggests that company managers should be able to weigh the merits of competing investments more effectively and make better decisions. It hasn't worked out that way. Cycles of overproduction and shortages still occur in the chemical and many other industries. What went wrong?

Venture appraisal has been my career, and I've seen a wide variety of project proposals and justifications as I have moved from project analyst through several steps of management to a seat on a board of directors. The profitability techniques used to justify proposals are still valid and the best available, but they must be used in new ways now to contribute to better investment decisions.

## Profitability analysis quantifies projects' potential return

There's no magic way to calculate potential profitability of an investment proposal—available techniques are simply mathematical models of an expected future situation. The first step is to decide just what elements will affect significantly the profitability of a proposed project. Detailed forecasts are needed for each of these elements, extending over the life of the project. One way of presenting such forecasts is by a cash-flow schedule. The example on the opposite page is typical and is derived from a real case for a new chemical plant producing two products. Note that almost all the key elements affecting profitability are reflected directly in such a schedule. The only exceptions are policy choices (depreciation life and minimum acceptable rate of return) and such background factors as forecasts of inflation rates or general business conditions.

Since the major parts of a new plant are likely to survive at least 10 years, that period often is chosen (as in the example) for the economic life of the plant. As with many other fairly arbitrary choices, however, each company should set a single standard "economic life" to use for new plants in all but exceptional cases, so that profitability studies will be comparable. A policy decision also must establish the depreciation method to be used in calculating cash flow. Although profits before or after taxes are important parts of the cash-flow schedule, only total cash flow, including depreciation, provides a full measure of the project's success.

The cash-flow schedule generated from any given set of forecasts summarizes all the essential information needed to assess the future of a project. That's important. The biggest costs in preparing a profitability analysis are in gathering all the data needed to develop such a schedule. Once data are available in the proper form, the final calculation is relatively simple, at least when compared with the procedures needed to estimate the data. Such calculation is further simplified by use of electronic computation, even on small hand-held calculators, to speed successive approximation procedures that are tedious when done by hand.

Cash-flow schedules are complex, however, so company officers and economic analysts have sought means to summarize the quantitative data into a single profitability measure. Decades ago, most companies used simple measures of profitability, such as the ratio of profits in a single early year to the original amount of investment (fixed plus working capital). But such ratios ignore much important information, such as trends during the life of the plant in prices, sales revenue, or various operating costs. By the early 1960's, two techniques, known as "present value" and "discounted cash flow rate of return," had been developed. They are still the best quantitative methods available for comparing various investments and selecting those best for company growth.

Both use compound interest techniques to discount cash flow (positive and negative) during the life of the project. This permits expression of the full sequence of cash flows as a single number representing the project's rate of return. (Obviously, the sooner projects return cash the better, so 10 years of individual annual cash flows just can't be added together.)

Each company has to choose a discount rate based on its time-value of money—either its cost of capital or something slightly higher to cover nonprofitable investments such as office buildings. This is its minimum acceptable rate of return. The present-value technique (also known as present worth or venture worth) discounts all the future cash flows at the chosen discount rate in order to reduce them to their net cumulative value at the start of the project. If this single cumulative present value is positive, the project earns more than the company's desired minimum rate of return. The present values of alternative projects competing at any one time for capital resources of a similar order of magnitude (whether mutually exclusive or not) then can be compared. This assumes the same discount rate is used and all the projects are discounted to the same point in time.

The discounted-cash-flow rate-of-return technique (also known as internal rate of return or interest rate of return)

### Forecasts of key cash-flow elements dominate profitability analysis

| | Likely accuracy of forecast |
|---|---|
| **Major influence on profitability** | |
| Installed cost of fixed investment | Good |
| Working capital | Fair |
| Sales volume forecast | Poor |
| Product price forecast | Poor |
| Raw materials | Poor |
| Other manufacturing and indirect costs | Fair to good |
| Inflation rates | Poor |
| Income tax rate | Fair |
| General business conditions | Fair to poor |
| **Intermediate influence on profitability** | |
| Economic life | Poor |
| Depreciation life | Good |
| **Minor influence on profitability** | |
| Construction period | Good |
| Salvage value | Poor |

Recall for a moment the 1960's, when currently used project evaluation procedures first gained widespread use. In the U.S., business cycles seemed to be waning, so that recessions were less of an unpredictable hazard in company decisions. Stable economic growth looked like it would continue, both in the U.S. and most of the rest of the world.

In this environment, the newly accepted profitability techniques looked better and better. A consensus by management on the most likely set of forecasts (variously known as "best estimate," "proposed case," or "base case") usually was easy to obtain. As a result, many companies painstakingly established procedures to provide logical internal review of every major investment before it was recommended for approval by their board of directors. These procedures are themselves complex, and in larger companies the number of individuals involved in forming a consensus grew; staff personnel often were involved in the reviews as well as line management. Although risks and the sensitivity of forecasts to business conditions often were discussed, the one best estimate was emphasized. Multiple sets of forecasts always were considered distracting in a presentation to the board of directors. Many directors serve part time and need some

seeks, by trial and error, to determine the highest interest rate that hypothetically could be paid on money borrowed for a project, based on the project's cash-flow schedule, and still let the project break even over its economic life. This breakeven discount rate then can be compared to the company's minimum acceptable rate of return to see if it meets that standard. It also can be compared to rates obtained from alternative or competing projects available at about the same time in order to select the most promising.

Note that both calculations represent expected profitability of a single cash-flow schedule (as in the example). Risk always exists that some of the forecasts used in developing the cash-flow schedule won't be correct, and such risk has increased in recent years. To grasp the possible impact of changes in one or more forecasts, other cash-flow schedules can be prepared, based on these changes, and their profitability calculated. Such calculations, called sensitivity studies, of various sets of forecasts represent the best way for management to arrive at a consensus in recommending a project for board approval. The studies also may be used to choose among projects, if resources are restricted, or to choose optimum characteristics (plant capacity or alternative processes, for example) for a project.

Several suggestions have been made in the past 20 years for improvements or modifications in present value or discounted rate of return techniques. These include the use of subjective probabilities (obtained by polling company officials) in making key forecasts, capital planning by use of linear programing, use of learning or experience curves (which tend to be swamped by inflation), and the altering of project-by-project profitability analysis by means of concepts derived qualitatively from long-range strategic planning. But there is little indication that any of these modifications are being used consistently in industry. We evaluated them at ICI Americas, but decided that none provided benefits worth the extra effort.

## Project cash-flow schedule shows data that, when discounted, measure project's profitability

| | Construction period | | Start-up year | | | | | | At capacity | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $ Thousands, current | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993[a] |
| **SALES REVENUE** | — | — | $ 501 | $1191 | $1597 | $1924 | $2088 | $2338 | $2527 | $2760 | $3002 | $3297 | — |
| Product 1 | — | — | 501 | 1031 | 1331 | 1517 | 1541 | 1722 | 1850 | 2008 | 2179 | 2385 | — |
| Product 2 | — | — | 0 | 160 | 266 | 407 | 547 | 616 | 677 | 752 | 823 | 912 | — |
| **COSTS** | 45 | 108 | 741 | 1212 | 1481 | 1660 | 1739 | 1886 | 1995 | 2149 | 2238 | 2434 | 171 |
| Purchased raw materials | — | — | 300 | 706 | 938 | 1086 | 1150 | 1295 | 1392 | 1534 | 1602 | 1752 | — |
| Maintenance, insurance, and taxes | — | — | 59 | 78 | 85 | 92 | 99 | 105 | 111 | 115 | 125 | 132 | — |
| Utilities and other operating costs | — | 2 | 117 | 222 | 277 | 327 | 360 | 383 | 414 | 448 | 484 | 524 | — |
| Depreciation (accelerated) | — | — | 233 | 206 | 181 | 155 | 130 | 103 | 78 | 52 | 27 | 26 | 171 |
| Commissioning and other project expense | 15 | 77 | 5 | — | — | — | — | — | — | — | — | — | — |
| Taxes during construction | 30 | 29 | 24 | — | — | — | — | — | — | — | — | — | — |
| **TAXABLE INCOME** | (45) | (108) | (240) | 21 | 116 | 264 | 349 | 452 | 532 | 611 | 764 | 863 | (171) |
| **CASH FLOW** | | | | | | | | | | | | | |
| Profit after tax, at 50% | (23) | (54) | (120) | 10 | 58 | 132 | 174 | 226 | 266 | 306 | 382 | 432 | (86) |
| Depreciation (add back) | — | — | 233 | 206 | 181 | 155 | 130 | 103 | 78 | 52 | 27 | 26 | 171 |
| Fixed assets | (607) | (536) | (35) | (18) | — | (20) | — | (23) | — | (26) | — | (29) | — |
| Investment tax credits | 52 | 46 | 3 | — | — | — | — | — | — | — | — | — | — |
| Net working capital change | (9) | (78) | (55) | (76) | (53) | (51) | (39) | (31) | (26) | (31) | (30) | (43) | 522 |
| **NET CASH FLOW** | | | | | | | | | | | | | |
| —Annual | ($587) | ($ 622) | $ 26 | $ 122 | $ 186 | $ 216 | $ 265 | $ 275 | $ 318 | $ 301 | $ 379 | $ 386 | $ 608 |
| —Cumulative, year end | ($587) | ($1209) | ($1183) | ($1061) | ($ 875) | ($ 659) | ($ 394) | ($ 119) | $ 199 | $ 500 | $ 879 | $1265 | $1873 |

**DISCOUNTED CASH FLOW RATE OF RETURN = 13%/year**

**PRESENT VALUE, ASSUMING MINIMUM ACCEPTABLE RATE OF RETURN OF 8%/YEAR = $472**

**Note:** Numbers in parentheses are negative. a Working capital and 50% of undepreciated asset values recovered in year 1993. Salvage value is assumed nil.

training even to absorb all aspects of a project evaluation procedure.

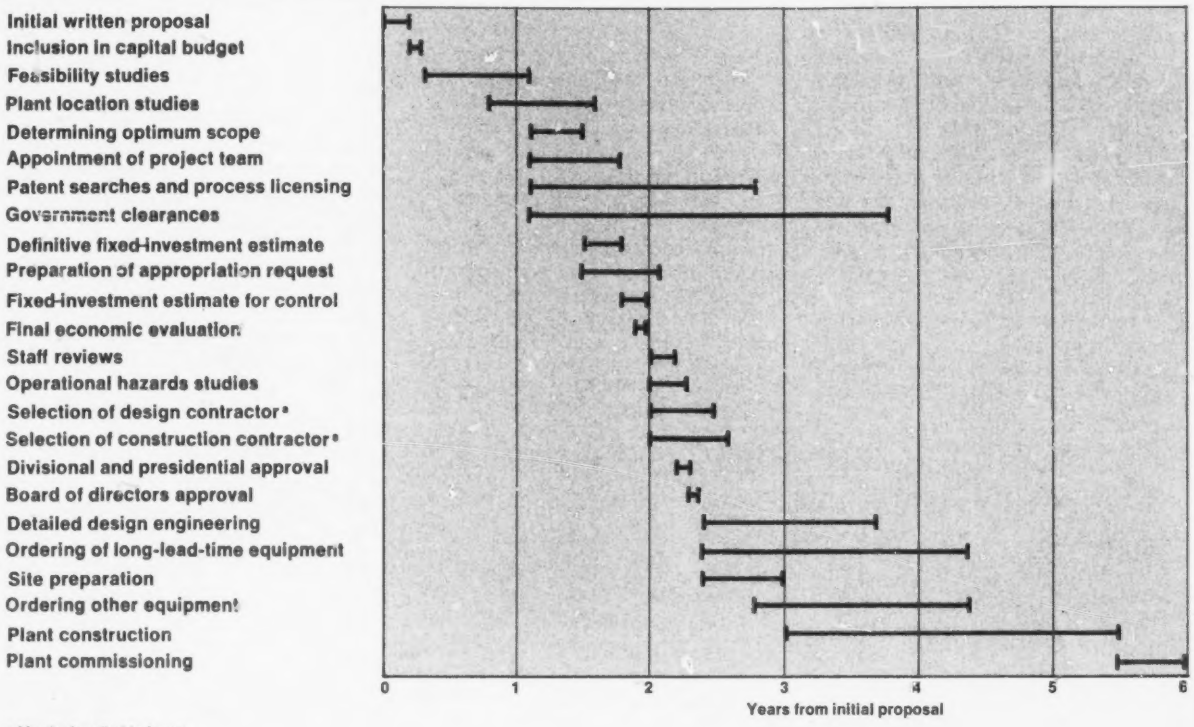
The business climate changed radically in the 1970's, and the changes are expected to continue through the 1980's. The usefulness of profitability techniques has been reduced as a result of increased uncertainty stemming from three economic developments:

- Re-emergence of sharp fluctuations in the business environment.
- Unpredictable inflation rates throughout the economy.
- Gyrations of floating currency exchange rates.

Each of these reduces the ability to foresee factors critical to forecasting investment profitability. The apparent continuing validity of the profitability techniques (and the acceptance of authorization procedures using them), however, may leave management with unwarranted confidence about its decisions.

A consensus of management on one set of forecasts is essential to profitability techniques used to evaluate an investment proposal when project authorization procedures are based on a single best-estimate case. But the best estimate is less certain now than it used to be and no longer may represent a broad consensus of management.

## Many steps lie on the long road between project proposal and operating plant




a May be handled in-house.

Consensus on a best estimate, in fact, may be impossible. Profitability analysis techniques now must be used, therefore, in ways that don't seem compatible with established authorization procedures. Although computers make it feasible to study projects under many sets of conditions, providing real insight into a range of possible futures, current authorization procedures don't permit use of such insights. Decisions increasingly need to be based on insights from a range of forecasts, even though key personnel may differ about the likelihood of achievement of certain key forecasts—or of the assumed future business environment.

A real problem remains unsolved—how to bring such disagreement and uncertainty to the surface, either within the company or in presentations to the board. It is difficult to display all the complex ramifications and still recommend a major project clearly enough to win its approval.

One need, therefore, is improved procedures to present results from a diversity of forecasts. Authorization procedures should not be tied simply to a best estimate when real consensus is absent.

Other hazards also result from the large number of reasonable sets of forecasts now possible. The cost of gathering all the data needed for many sets of forecasts is higher, for one thing. And the computer printouts do not automatically show key assumptions. It's also tempting for project champions—at any level in the company—to propose one reasonable set of forecasts that they think will meet company standards—even if it really is no more likely than other sets of forecasts.

Commodity chemicals, sold to specification, should be pretty independent, of course, of the whims of fashion. If all commodity producers view market growth in the same way, and use similar profitability evaluations in making their investment decisions, those decisions generally should eliminate cyclic shortages and over expansion. Instead, even in periods of relatively stable market growth, some companies seem to base some decisions on goals other than short-term profitability. They may seek a higher market share, for example, even at some sacrifice of price and profitability, or they may desire entry into new markets.

Whatever the cause, commodity chemicals still regularly undergo surpluses and shortages, along with wide price fluctuations, and these never can be foreseen in making a typical profitability evaluation. The stimulating growth that everyone, including myself, expected for commodity chemicals and plastics a few years ago has fizzled. Polyvinyl chloride, thermosetting plastics, and chlorine are all well-publicized examples—and similar examples can be found in nonchemical industries.

### From project proposal to operating plant

Every major investment project must go through many steps before it starts operation. Long experience shows that none of these steps can be skipped with impunity, although in total they usually consume three to five years, or even more for complete new plants. This means that forecasts of key project variables must be made long before the project is authorized—and even further before plant startup. If the business environment meanwhile changes drastically, the forecasts may become obsolete. Chemical equipment is so specialized that, past a certain point, incorrect decisions result in large sunk costs. That's

why major plants or expansions are such important decisions for corporate directors.

In an acquisition, the size of the facilities being acquired usually is fixed. Therefore, there's less opportunity to choose among alternatives during the acquisition's evaluation. By contrast, feasibility studies of internal projects, whether plant expansions or completely new plants, may be numerous. Early economic evaluations may be very helpful during these studies in settling on the final scope of a project. After such preliminary studies, management proceeds to a definitive cost estimate of the chosen scope, which may be unlike the scope envisioned in preparing previous capital budgets.

On major projects, feasibility studies generally precede preparation of the approval documents, although there may be some overlap. Even with most inputs in hand, an authorization request may itself require weeks or months to prepare, particularly when changes in the business climate require new forecasts of key elements. Projects requiring board approval then must await the board's next meeting, another delay. This period can be used to obtain agreement of operating management, both line and staff, on all aspects of the proposal. But every delay makes all the forecasts used in the approval that much less accurate. The whole stage of the business cycle may change during the period in which the project is being studied, approved, and developed.

The biggest improvement in the use of profitability techniques in recent years is the availability of computer models, covering the full life of a project. Every conceivable piece of relevant information needed to develop a cash-flow schedule can be incorporated into such a model. For preliminary studies, when specific data for a project are not yet available, average or standardized data from similar, previous projects can be used to make a preliminary evaluation. As new or revised data become available or as new assumptions are suggested by anyone in the company, they too can be incorporated into the model in only minutes or, at most, hours.

The main advantages of such computer processing—speed and precision—more than offset its disadvantages. Today's speed of preparing evaluations of new project proposals could only be dreamt about 20 years ago. Computer procedures also can eliminate the possibility of arithmetic error, which avoids tedious checking and rechecking of numbers. However, the computer's precision is not matched by its accuracy; the human interface must be maintained to ensure that the data and assumptions fed into the computer are logical and internally consistent. This points to a disadvantage: Projected cash-flow schedules, the normal computer outputs, often are studied more carefully than critical input assumptions. Management, as well as analysts close to the model, should review current assumptions carefully as the time to make decisions approaches. Computer printouts can be designed to supply management with an intelligible listing of assumptions. Furthermore, the identity of individuals or reports that are the source of each key input for a forecast also should be available from the computer's memory, if possible.

Just before a decision is made, management personnel have a remarkable ability to dream up new and interesting changes among the elements used to project a cash-flow schedule. That's good. With most parts of the cash-flow schedule already in the computer, forecasts can be modified very quickly. Even modifications in key assumptions suggested by board members can be dealt with at the last minute.

Unfortunately, there is no simple way to summarize a mass of separate cash-flow schedules. Each involves differing assumptions and is a complete evaluation unto itself. And because the future is unpredictable, there is even less chance of a consensus on the forecasts. Any of a number of evaluations could turn out to be the most accurate and, therefore, the proper basis for a decision. But nobody has suggested a way for either authorization papers or the board itself to deal with a wide array of forecasts.

Another recent development that is heartening is the growth of specialized staffs formed specifically to make profitability evaluations. Because of their repeated exposure to all aspects of such analyses, specialists can bring key assumptions to the attention of decision makers, given the opportunity, and suggest improvements in projects. Experience in such work also provides useful training for future company management.

Such a staff must be protected and made independent of operating management, however, so that its evaluations are objective and not merely made to back a decision already favored by the operating management. And it must be treated by management, at all levels, as a partner in seeking the best decision. If the evaluation staff works within an operating group, it will be all too subject to the short-term pressures of day-to-day operations. Then it is far too easy for the staff, like everyone else in the group, to drift too soon into unanimity regarding a course of action, before all the business options have been thoroughly reviewed. Once such unanimity develops in an operating group, group management is likely to treat an analytically oriented, skeptical project evaluation staff more like adversaries then helpmates.

#### An unpredictably capricious environment

Improvements in profitability evaluations stemming from the growing use of computers have been swamped in recent years, in my opinion, by the three major churlish elements now affecting business: shorter and more severe business cycles; unsteady, uneven, and high rates of inflation; and wide fluctuations in monetary exchange rates. These developments explain why, despite business's acceptance of profitability techniques during the past 20 years, business decisions nevertheless have become more and more difficult and no more successful. The record of profitability for most chemical companies has continued to swing up and down, just as if their managements didn't know how to make major decisions correctly or weren't following any consistent procedures. The new elements in the business environment have not destroyed the relationships in the cash-flow schedules or the validity of accepted profitability techniques. But they do destroy confidence in forecasts, so that a consensus on a single set of forecasts for an investment project is harder to achieve.

In developing a 10- or 15-year cash-flow schedule, one has to assume a stable business environment, usually one growing steadily throughout the period under study. Sales volume and price assumptions also must be based on a stable environment. And the timing of cash flows is critical; because future earnings are discounted, the profitability of a project depends heavily on its achieving the sales volumes and profit margins forecast for it in its early years.

But the more pronounced business cycles of the 1970's are expected to continue. No suitable way has been found to handle such cycles and the resulting uncertainties regarding future income within current profitability techniques; the impact of a recession of any given mag-

nitude can be shown, but the probability of its actually occurring is uncertain. Unless economists improve their ability to forecast the onset and depth of recessions, we are left with an unresolved problem.

The chemical industry went through two complete business cycles during the 1970's. Since the span from idea to approval to plant startup is about the same as from cycle to cycle, a plant rarely comes on stream in the same business environment as when it was approved.

Forecasting is not scientific; the business environment strongly affects the opinions of any forecaster. If a plant is proposed at a low point in the economy, price and sales volume forecasts will not be optimistic (or won't be accepted if they are) and the project probably won't be approved. However, if it is, the plant might start up when the economy is at its peak—and industry sales volumes and prices for the product may be well above what had been originally forecast.

Conversely, approval for projects is easier when the business cycle is at a peak; a good business climate leads to optimistic forecasts that also are more readily accepted by management. However, if the plant comes on stream at the bottom of the cycle, sales and prices may well be more disappointing than forecast.

#### Unsteady and uneven inflation

Inflation has been unsteady in recent years and uneven in its impact on individual products in any given year, even among relatively similar commodity chemicals.

From the beginning, the toughest forecasts to make in project evaluations were of sales volume and selling price. They have become even more difficult because of business cycles and inflation. The minor inflation usual in the 1960's could safely be ignored in project evaluations, but higher inflation rates in the 1970's demanded some sort of consideration. High inflation rates seem likely to continue in the 1980's, and no satisfactory method of forecasting prices of individual products yet surfaced.

### Sharply varying inflation rates make cost and price forecasting difficult

| December-to-December annual change, % | 1980 | 1979 | 1978 | 1977 | 1976 | 1975 |
|---|---|---|---|---|---|---|
| GNP deflator | 9.8% | 6.9% | 8.6% | 5.8% | 4.7% | 7.5% |
| Consumer price index | 12.4 | 13.3 | 9.1 | 6.7 | 4.8 | 7.0 |
| Chemicals and allied products | 12.6 | 17.7 | 4.2 | 3.1 | 2.6 | 5.4 |
| Industrial chemicals | 14.5 | 27.6 | 1.7 | [illegible] | 4.9 | 8.4 |
| Crude petroleum | 26.6 | 50.7 | 8.4 | 9.0 | 0.7 | 17.8 |
| Ethylene | 21.5 | 41.7 | 2.0 | 5.6 | 12.3 | 26.3 |
| Ethylene dichloride | 13.4 | 25.2 | −13.3 | 8.4 | 4.5 | 24.0 |
| Chlorine | 2.5 | 3.9 | −0.1 | −3.2 | 4.2 | 21.5 |
| Sodium hydroxide | 40.1 | −8.3 | −4.6 | −2.5 | −3.9 | 32.0 |
| Sulfuric acid | 25.4 | 6.9 | −0.7 | 2.8 | −2.0 | 11.5 |
| Raw cane sugar | 62.2 | 26.6 | 13.4 | 22.4 | −27.6 | −69.9 |
| Lard | 4.8 | −3.4 | 5.5 | 21.8 | 18.4 | −43.7 |
| Inedible fats and oils | −3.1 | −1.7 | 25.1 | 4.5 | −1.0 | −2.6 |
| Domestic cathode copper | −15.5 | 47.1 | 17.5 | −9.4 | 3.1 | −13.8 |
| Silver | −15.5 | 239.6 | 26.0 | 5.9 | 11.1 | −4.9 |
| Nickel—new scrap | −4.1 | 58.7 | 0.0 | −8.0 | 4.1 | −15.7 |

Source: Bureau of Labor Statistics, Bureau of Economic Analysis

If inflation were steady over time and affected all raw materials and other cost elements equally, published mathematical techniques show how to include inflation in profitability calculations. Even inflation rates that vary from one cost element to another can be handled, if the effect on each cost element is steady and foreseeable. But inflation not only differs among the various cost elements at any given time, it also cannot be predicted accurately. Who could have foreseen the sharp differences in inflation for various products that occurred since 1970?

Although forecasts of inflation are available from several sources, they differ and change often. Moreover, each is tied to a complex set of assumptions about business conditions, to which a user must also agree. Most forecasts indicate that inflation gradually will decline during the 1980's back to a level with which we can cope. Unfortunately, such optimism has not yet proven justified.

In the pleasant world of the 1960's, when inflation was slight, business cycles not in evidence, and costs and prices stable, current profit margins could be taken as a reliable measure of future expectations. A projected cash-flow schedule could be assembled from a stable set of cost elements, especially for familiar products and processes. (Even today, a cash-flow schedule based on current costs and prices, ignoring inflation, may be useful in preparing a profitability evaluation; it would indicate whether current profit margins are sufficient to support the investment project.)

But even assuming relatively constant inflation, it's not clear how today's profit margin must be increased to maintain in the future a profitability equivalent in purchasing power to the company with that it has today. Since the value of money is falling, a margin fixed in dollars per pound of product is also dropping in value. On the other hand, if the percentage margin of price over costs is maintained during a 10- or 15-year project life, the dollar margin will rise sharply with only a few years of high inflation. This will raise the calculated rate of return but may or may not increase the purchasing power of the profits.

Of course, minimum acceptable rates of return must be higher during a period of high inflation than what was acceptable previously, to compensate for the inflation. But just how much higher depends on an accurate forecast of all costs and prices, which now is impossible.

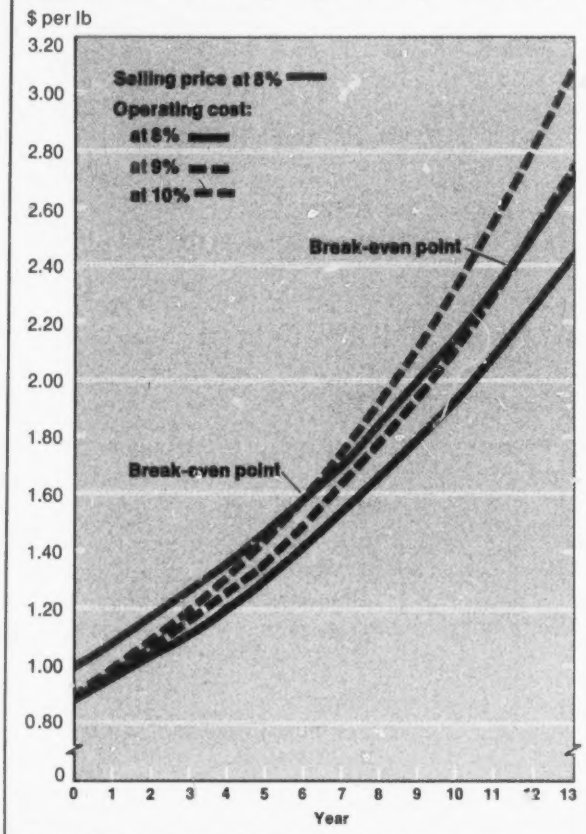
It's obvious, then, that economic evaluations cannot simply assume, as is often done, that all prices (raw materials and products) as well as project costs will rise at some average rate accepted by company management. Labor and other operating costs may rise at one rate while prices of raw materials and finished products increase at much higher or lower rates. And construction costs rose faster than average throughout the past 50 years (until very recently). Therefore, inflation rates must be forecast for each element in a project's cash-flow schedule to determine future costs and selling prices.

#### Gyrating exchange rates

Although the value of national currencies fluctuated before the current period of floating foreign exchange rates, recent variations have been wider and less predictable. Exchange rates are important in justifying investment projects whenever exports are significant or foreign plant locations are being considered.

One example from ICI Americas, the British-owned company I worked for, may illustrate the problem. Funds for capital projects were authorized by ICI in pounds

## Inflation has a sharp impact on profitability




Even relatively small differences in inflation rates for costs and selling prices can affect profit margins drastically, as the chart above indicates. (The chart represents a somewhat simplified case, in that all operating costs are assumed to be completely variable rather than a mixture of fixed and variable items.) Precision in forecasting costs is impossible, however, making project analysis a very uncertain endeavor.

In the case charted, a product that costs 90 cents a lb to produce at present sells for $1.00 a lb for a 10% profit margin. The selling price is assumed to increase at a steady 8%-a-year rate. If the manufacturing costs also rise steadily 8% a year, the profit margin remains at 10%—although in 10 years profits per pound increase from 10 cents to about 22 cents a lb. If, however, costs increase 9% a year, only one percentage point faster than prices, profit margins erode steadily and disappear in 11 years. And if costs rise 10% a year, the break-even point for the product is reached in only six years.

sterling. When a major expansion in the U.S. encountered a significant overrun in dollars, explanations obviously were called for. But imagine our surprise to find that, because the dollar value of the pound was less than had been forecast at the time the project had been approved, the overrun in British currency was negligible. Recent decreases in value of the pound must now be creating other situations where a considerable cost overrun in dollars nevertheless may show an underrun in pounds.

Like many companies, ICI forecasts inflation and exchange rates each quarter for use throughout the company. Major projects took many months to assemble prior to final recommendations and more months to gain approval in both the U.S. and the U.K. Meanwhile, these quarterly corporate forecasts of inflation and exchange rates changed. Therefore, forecasts used in an authorization proposal were often obsolete before the project was submitted for final approval.

These variations usually did not change the final presentation of a proposal significantly. Volatile exchange rates, and changing forecasts thereof, nevertheless, can determine the results of certain studies. Theoretically, in a stable world economic environment, profitability techniques could be used to plan optimum worldwide strategy for locating new plants to make products such as commodity chemicals that are sold to identical specifications throughout the world. In one study at ICI, however, the relative value of a European plant, compared to a U.S. plant, depended on whether we worked in U.S. currency, using current exchange rate forecasts, or the European currency. A further study using the company's earlier quarterly exchange-rate forecasts showed that forecast profitability levels and comparisons of operations in the two regions depended heavily on when the forecast was done, simply because of changes in forecast of exchange rates.

Some analysts believe that differences in inflation rates between countries largely offset changes in the relative values of their currencies. While this seems logical, many other influences affect both, and our studies showed little correlation between the two.

I have been a major promoter and user of profitability techniques, and I still am. Such techniques still provide a useful means to analyze a potential cash-flow schedule. However, a more perverse and capricious business environment has made forecasting more difficult, so that each cash-flow schedule and profitability calculation is far less useful than was the case 20 years ago. The best estimate is much less likely to occur, so consensus on a set of forecasts is rare. Computer models permit display of an endless variety of results, to show sensitivities, but none has a high probability of being closest to the truth.

Proper use of profitability evaluations requires that each forecast be given less weight than before but that a variety of reasonable forecasts be made to show the wide range of possible future cash flows. Less emphasis should be placed on attaining a consensus or preparing a persuasive presentation around one best estimate; instead, ranges of key assumptions should be presented and their impact on future profitability discussed. This admittedly raises problems when corporate directors seek brevity and clarity in the proposals presented to them. But the alternative is worse: decisions made without the true risks of an investment having ever surfaced.

The biggest roadblock to accomplishing these changes, however, may be the very nature of the proposal authorization procedures used in large corporations. Like profitability techniques, these developed as part of scientific management, but they now are obsolete if they rely solely on a single best estimate. This is true even if the profitability techniques themselves are still valid. But authorization procedures are complex and hard to change. Boards of directors and operating management also are familiar with current techniques and formats and therefore usually loath to change.

As long as current authorization procedures are used, though, a greater hazard exists. Because a variety of cash-flow schedules can be turned out by a computer, it is tempting to choose a favorable one as the best estimate, whether it is more probable than others or represents a

real consensus. Improved computer models and the speed of computer calculation lend an aura of confidence to the best estimate forecasts, whether it is justified or not.

In many ways, the variety of possible forecasts and evaluations puts the basis for making decisions back on the intuition of company management and directors. Faced with many forecasts of cash-flow schedules in mesmerizing detail, decision makers may feel they must again make seat-of-the-pants judgments, much like early entrepreneurs. Nevertheless, they are better informed with an array of cash-flow schedules than without; the schedules at least allow the best possible application of business intuition.

Maybe better techniques can be found, particularly for summarizing the variety of cash-flow schedules into a simple presentation. But until they are found, the whole array of cash-flow schedules is needed if the best-informed decision is to be reached. □

**Selected readings**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*James B. Weaver was vice president for venture and capital appraisal of ICI Americas before retiring last year and establishing his own venture consulting business. After earning a B.S. (1944) and M.S. (1947) in chemical engineering from Massachusetts Institute of Technology, Weaver held staff positions in the research departments of Godfrey L. Cabot Inc. and Olin Industries. He joined the economic evaluation staff of Atlas Powder (later Atlas Chemical Industries) in 1954. He was appointed vice president of ICI America in 1973, the year after Atlas had been acquired by Britain's Imperial Chemical Industries, and elected a director of ICI United States in 1974. Weaver has written numerous articles on cost engineering, economic evaluation, and profitability appraisal techniques (including one in C&EN, Sept. 25, 1961, page 94), and he is coauthor of a chapter on cost and profitability estimation in "Chemical Engineers Handbook," edited by Robert H. Perry and Cecil H. Chilton.*


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